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Specification for a Refractivity Structure Matching Algorithm

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ABSTRACT

The Refractivity Structure Matching Algorithm (RSMA) is an automated aid for matching refractivity structures in adjacent profiles which result from common layers. The RSMA is specifically designed to prepare multiple refractivity profiles for entry into the Naval Ocean Systems Center's Radio Physical Optics (RPO) program. A full description of the RSMA, a test case demonstrating its capabilities, and a computer listing, are provided in this document.

ACKNOWLEDGMENTS

The support of the sponsor, Office of Naval Technology, Mr. J. Cauffman, Program Element 62435N, is gratefully acknowledged.

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SPECIFICATION FOR A REFRACTIVITY STRUCTURE MATCHING ALGORITHM

1. INTRODUCTION

Refractivity layers in the lower atmosphere result from rapid vertical changes in air temperature and/or humidity. Variations in refractive structures over altitude and range may significantly affect electromagnetic propagation. In order to represent the evolution of refractivity layers with range, the Refractivity Structure Matching Algorithm (RSMA) has been developed. The RSMA is specifically designed to prepare multiple profiles of M-units versus height, as a function of range, for entry into the NOSC range-dependent Radio Physical Optics (RPO) model (NOSC, 1991).

The methodology used in the RSMA to match up refractive structures in adjacent profiles that result from common layers follows procedures developed at the John Hopkins APL (Konstanzer and Dockery, 1989; Konstanzer, 1989). Prior to matching, each point on each refractivity profile is categorized as being one of 31 structural types, based on the profile M-gradients immediately below and above the point, and the magnitude and direction of the change in these gradients across the point. Structure types in adjacent profiles are next matched up in a specific order based on a hierarchy, such that the structures considered most likely to affect propagation are matched first. Data points not initially matched by the hierarchal pairings are matched by the addition of points to the profiles by interpolation. This secondary matching ensures that two important RPO data requirements are met, namely, 1) every profile has the same number of points and 2), the nth point in any one profile is matched to the nth points in the other profiles.

2. ALGORITHM FUNCTIONS

2.1 Inputs, Outputs and Limits

The following parameters and refractivity field data are required by the RSMA and need to be specified by the operator:

1) Number of M-unit versus height profiles - 2 to 11

2) Number of data points for each profile - 3 to 30

3) Couplets of M-units and height for each profile, corresponding to profile data points.

4) Height unit - ' m' or 'ft'

5) Range for each profile - >= 0.

6) Range unit - ' km', ' mi' or 'nmi'

The first profile specified must be for a range of zero; the range of subsequent profiles must be greater than the range of the previously entered profile. The RSMA places no numerical limits on either height or M-unit values; however, height array values must be specified in ascending order and all height profiles must have the same value for the first (and last) array elements.

After RSMA execution, profiles defined by height and M-unit data couplets are specified, along with the number of profile data points (i.e., profile levels). As required by the RPO program, all RSMA output profiles have the same number of points (levels), with the nth point in any one profile matched to the nth point in the other profiles. In general, the number of profile levels determined by the RSMA depends upon the number of profiles, the number of profile points, and the number of common refractivity features matched between profiles. A priori, this last element is not known. Operationally, to have a decent likelihood in meeting the current RPO requirement of no more than 51 levels, the maximum possible number of levels after RSMA execution, nlvmx, given by

$$nlvmx = \Sigma\ npt(i) - (nprf*2) + 2\ ,$$

where npt(i) is the number of points in the ith profile and nprf is the number of profiles , should not exceed the RPO limit by more than 50% (nlvmx = ~ 75) prior to RSMA execution.

Output profiles correspond to those originally specified by the operator in regards to number, range and units. A sample RSMA output is presented in the Appendix; these same data are depicted graphically in Section 3. Graphics and profile interpolation to intermediate ranges are not included with the RSMA; these functions are provided by the RPO program.

2.2 Data Point Categorization

Refractivity layers in two adjacent profiles may be matched provided the layers have the same, or similar, structure categories. In the RSMA, categories are assigned to each data point of each refractivity profile, based on profile M-gradients below and above the point, and the change of these gradients across the point. For the nth point of the ith profile, the M-gradient (in M units/km) is defined as

$$dM/dz(i,1) = 0.$$

and

$$dM/dz(i,n) = 1000. * (\ M(i,n)-M(i,n-1)\ /\ z(i,n)-z(i,n-1)\ )$$

where M is the modified refractivity in M-units, and z is the height in meters.

The M-gradient defines the four basic types of refraction:

Trapping - TRP	< 0	M-units/km
Superrefractive - SUP	>= 0 to < 78	M-units/km
Standard - STD	>= 78 to < 157	M-units/km
Subrefractive - SUB	>= 157	M-units/km

The change in the M-gradient across the nth point of the ith profile (in M-units/km) is defined as

$$\Delta\,(dM/dz)(i,n) = 0. \qquad \text{for } n = 1 \text{ and nmx}$$

where nmx is the last (highest indexed) data point, and

$$\Delta\,(dM/dz)(i,n) = dM/dz(i,n+1) - dM/dz(i,n) \qquad \text{for } n = [2,\text{nmx}-1]$$

Table 1 presents the 31 data point structure types. These categories are given by integers over the range [-15,15]. Negative (Positive) categories indicate a decrease (increase) in M-gradient across a data point. Positive and negative categories of like absolute value have been specified as "mirror" images of one another. The categorization of profile data points is based on a hierarchy, chosen to characterize which structures are most likely, and least likely, to affect propagation. The structure type '15' ('-15'), which defines a M-gradient change from trapping to subrefractive (subrefractive to trapping) across a data point, is considered to be of most importance. On the other hand, the structure type '0', which signifies an absolute change in M-gradient of less than 39 M-units/km across a data point, is considered to be the least important. The first and last points of all profiles are assigned the structure type '15'; this ensures that the bottoms and tops of adjacent profiles are always matched up.

2.3 Matching

2.3.1 <u>Primary</u>

Refractivity structures in adjacent profiles may be matched to each other provided that they are of like or similar categories, and fall within a certain altitude window. A hierarchal classification of paired structure types, given in Table 2, is used to ensure that those refractivity structures deemed most important are first matched. This hierarchy defines the order in which structures in one profile (A) are to be matched to structures in the adjacent profile (B). The first 30 pairs of (profile A, profile B) categories match exact structure types between the two profiles.

Table 1. Profile structure type categories for the nth point of the ith profile, based on M-gradients below and above the data point, and the change in the M-gradient across the point. M-gradients are given as TRP, SUP, STD and SUB.

dM/dz(i,n)	dM/dz(i,n+1)		Δ (dM/dz)(i,n) M-units/km			
(below)	(above)	≤ -78	(-78,-39]	(-39,39)	[39,78)	≥ 78
SUB	TRP	-15				
STD	TRP	-14				
SUB	SUP	-13				
SUP	TRP	-12				
STD	SUP	-11				
SUB	STD	-10				
TRP	TRP	- 9				
SUB	SUB	- 8				
SUP	TRP		- 7			
STD	SUP		- 6			
SUB	STD		- 5			
TRP	TRP		- 4			
SUP	SUP		- 3			
STD	STD		- 2			
SUB	SUB		- 1			
---	---			0		
SUB	SUB				1	
STD	STD				2	
SUP	SUP				3	
TRP	TRP				4	
STD	SUB				5	
SUP	STD				6	
TRP	SUP				7	
SUB	SUB					8
TRP	TRP					9
STD	SUB					10
SUP	STD					11
TRP	SUP					12
SUP	SUB					13
TRP	STD					14
TRP	SUB					15

Table 2. Hierarchy of the 114 pairs of structure types for matching. Note that the first 15 match combinations have 2 permutations, and the last 21 have 4 permutations.

MATCH COMBINATION	PERMUTATIONS 1	2	3	4
1	-15 -15	15 15		
2	-14 -14	14 14		
3	-13 -13	13 13		
4	-12 -12	12 12		
5	-11 -11	11 11		
6	-10 -10	10 10		
7	-9 -9	9 9		
8	-8 -8	8 8		
9	-7 -7	7 7		
10	-6 -6	6 6		
11	-5 -5	5 5		
12	-4 -4	4 4		
13	-3 -3	3 3		
14	-2 -2	2 2		
15	-1 -1	1 1		
16	-15 -14	15 14	-14 -15	14 15
17	-15 -13	15 13	-13 -15	13 15
18	-14 -13	14 13	-13 -14	13 14
19	-14 -12	14 12	-12 -14	12 14
20	-14 -11	14 11	-11 -14	11 14
21	-13 -10	13 10	-10 -13	10 13
22	-13 -11	13 11	-11 -13	11 13
23	-15 -12	15 12	-12 -15	12 15
24	-15 -10	15 10	-10 -15	10 15
25	-15 -11	15 11	-11 -15	11 15
26	-14 -10	14 10	-10 -14	10 14
27	-13 -12	13 12	-12 -13	12 13
28	-12 -11	12 11	-11 -12	11 12
29	-11 -10	11 10	-10 -11	10 11
30	-12 -9	12 9	-9 -12	9 12
31	-10 -8	10 8	-8 -10	8 10
32	-12 -7	12 7	-7 -12	7 12
33	-11 -6	11 6	-6 -11	6 11
34	-10 -5	10 5	-5 -10	5 10
35	-9 -4	9 4	-4 -9	4 9
36	-8 -1	8 1	-1 -8	1 8

The remaining 84 pairs, which match structures of similar categories, have been ranked according to a subjective judgment as to how individual pairings likely affect propagation. In a general way, the 114 hierarchal pairings of Table 2 may be construed as being 36 principal match combinations, of which the first 15 contain two permutations, and the remaining 21, four permutations each. The numerous pairs of structure match categories which do not appear in Table 2, such as (-7,-4) or (7,6), are considered minor pairings, and are not used by the RSMA.

Given two adjacent profiles (A and B), the RSMA's primary matching scheme begins by searching, from the bottom and working upward, profile A data points for the structure type which corresponds exactly to the appropriate (i.e., profile A) value of the first hierarchal match pairing. If the appropriate structure type cannot be found in profile A, the next pair of match categories are considered, and a similar search is made for the profile A structure type corresponding to that hierarchal pairing. This search process terminates when all 114 pairs of match categories have been tried and is only interrupted when the search successfully finds the required profile A structure needed for matching.

Given an appropriate profile A match category, an altitude window is next determined for matching. This window requires that, for matching, structures in adjacent profiles be within reasonable physical (i.e., vertical) bounds. The size of this window is variable, and is a function of both the range between profiles and the altitude of the structure being matched. Specifically, the range dependence of the window (RDEP) is given by

$$\mathrm{RDEP} = \mathrm{RFCT} * \Delta\ \mathrm{range}$$

where RFCT is a constant corresponding to an altitude over range slope of 1/1000, and Δ range is the difference in range between two adjacent profiles.

For Δ range in km (nmi) and RDEP in m (ft), RFCT = 1.00 (6.08).

The altitude dependence of the window (ZDEP) is given by

$$\text{ZDEP(ft)} = 200. \qquad \text{for } z(i,n) < 100 \text{ ft, and}$$

$$\text{ZDEP(ft)} = 100. * \log_{10} z(i,n) \qquad \text{for } z(i,n) >= 100 \text{ ft ,}$$

where z(i,n) is the altitude of the profile A structure to be matched. ZDEP values in meters correspond exactly to these formulae.

The altitude window for structure type matching between adjacent profiles is given simply as

$$\text{WNDW} = \pm (\text{RDEP} + \text{ZDEP})$$

In general, the greater the distance between profiles and, the higher the structure to be matched, the larger the altitude window. As an example of a WNDW calculation, consider z(i,n) = 1000 ft and Δ range = 25 nmi. Here, WNDW would be $\pm$ 452 ft, or from an altitude of 548 to 1452 ft.

Once a window has been established, the RSMA attempts to find a profile B structure type within that window which corresponds to the appropriate category match pair. If the search is successful, the profile A and profile B structure types (data points) are considered matched. If more than one profile B structure type within the window is a match, then the profile B structure type (data point) nearest in elevation to the profile A data point (z(i,n)) is chosen. If a profile B category match cannot be found within the window, the next profile A data point (at height z(i,n+1)) is considered for matching. Already matched profile structures place an important limitation on subsequent matching. Specifically, given an existing match between the nth data point of the ith profile and the mth data point of the i+1 profile, the RSMA does not permit an ith profile data point above (below) the index n to be matched with a i+1 profile data point below (above) the index m.

Once the primary matching procedure has been completed for the first two profiles, it is repeated again for the second and third profiles, and so forth, until matching has been attempted between all adjacent profiles. Upon conclusion of this part of the RSMA, it is possible to have defined refractivity structures common to several profiles and extending over considerable horizontal extent, or structures only common to two profiles and of limited horizontal range.

2.3.2 Secondary

The RSMA secondary matching procedure matches all profile data points which remain unmatched initially. Such data points either correspond to minor refractivity structures or, significant structures which fade rapidly over range (i.e., from one profile to the next). Secondary matching is essentially an interpolative process, in which an unmatched data point in a particular profile is matched to new data points in all the other profiles. On conclusion of this process, every profile will have the same number of data points, with the nth data point in any one profile matched to the nth points in the other profiles.

Secondary matching is done in two directional sweeps, first forward, then backward, starting with the first two profiles (A and B, A at zero range). Assume that there exists an unmatched profile A data point (structure) at a height Z1 located between previously matched (by the primary matching procedure) profile A data points at heights ZB1 (below) and ZT1 (above). Further assume that the profile A points ZB1 and ZT1 have been previously matched (by the primary matching routine) to profile B data points ZB2 and ZT2, and that there exists no other primary matched structures between ZB1-ZB2 and ZT1-ZT2. Then, a profile B height Z2, corresponding to a new match with the profile A data point at Z1, is obtained by

$$Z2 = [\ \{\ (Z1-ZB1)/(ZT1-ZB1)\ \}\ *\ (ZT2-ZB2)\ ]\ +\ ZB2\ .$$

This formula is applied to all profile A unmatched data points. On conclusion, the new interpolated profile B altitude values are inserted (by means of sorting) into the profile B height array at the appropriate locations. Provided that there are at least three profiles, the secondary matching procedure is next repeated, with the newly augmented second profile as profile A and the third profile as profile B, and so forth, until the final profile is reached. As the procedure steps forward, the number of unmatched data points at any particular ith profile A will be greater than the number for the previous (ith-1) profile A, provided that the ith profile itself has data points not initially matched by the primary matching routine. Once the last profile (at the maximum range) has been reached, the secondary matching process is reversed: the last profile becomes profile A and the next to last, profile B. Upon completion of matching between these two profiles, backward matching is repeated, with the newly augmented profile B as the new profile A and the third to last profile as profile B, and so forth, until the first profile (at zero range) has again been reached. At this point, all profiles will have the same number of data points (i.e., levels), and the nth point of any profile will correspond to the nth points of the other profiles. Redundant data points (levels) are next removed from the profile arrays. Finally, refractivity M-values are calculated for all newly interpolated height array values, by means of vertical interpolation of existing M-values to these heights.

3. TEST CASE

To test the RSMA, high resolution refractivity field data (M-profiles), corresponding to a Pt. Loma to Guadalupe Island transect of 12 March 1948, were utilized. This data, shown in Figure 1, consist of five M-units versus height profiles, at ranges of 0, 80, 120, 160 and 200 nmi. All profiles extend from sea level to a height of 3500 ft. The number of profile data points is 28 for each of the first three profiles, and 24 each for the two profiles at the greatest ranges.

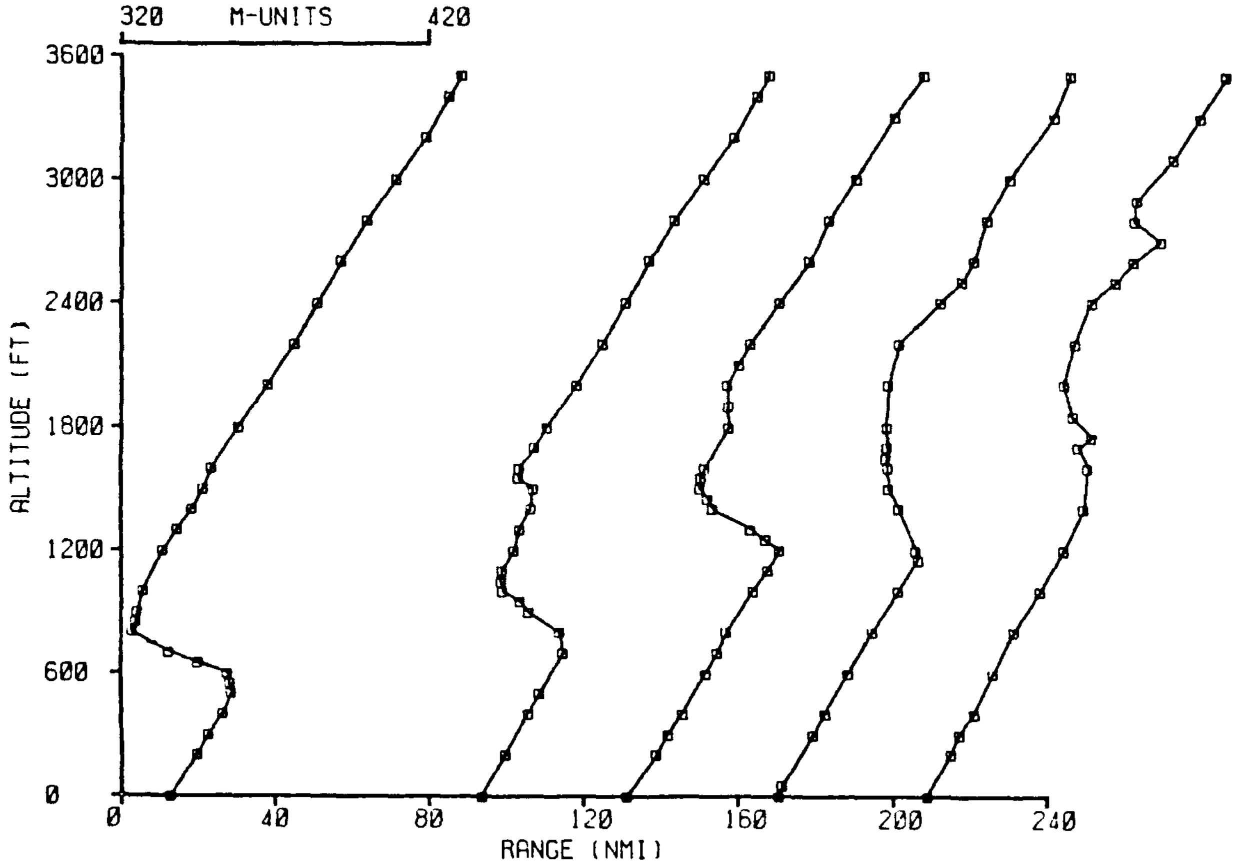

Figure 1. Refractivity field data, for a Pt. Loma to Guadalupe Is. transect of 12 March 1948. M-profiles are at ranges of 0, 80, 120, 160 and 200 nmi. Profile values are given by the projection of the M-scale onto the horizontal at the desired range.

Figure 2 depicts results from the RSMA after primary matching. Here, line segments denote matched structures; note that there are many profile data points which were not matched. The most prominent refractivity feature matched is a trapping layer sloping upward from about 600 ft at zero range to around 1600 ft at 200 nmi range. Other refractivity structures are observed not to extend over all ranges. The strong trapping layer near 2700 ft at range 200 nmi is seen to fade rapidly over range, and can only be matched 40 nmi inward. As required by the RSMA, the bottoms and tops of all profiles are matched.

While the overall matching appears quite favorable, the matching of the 16th data point of the second profile (at a height of 1550 ft) with the 15th point of the third profile (at a height of 1500 ft), both of structure category '12', likely would not have been done by an expert analyst. More likely, such an expert would have matched the 10th point of the second profile (at a height of 1050 ft, and structure category '7') with the 15th point of the third profile. While a (7,12) category pairing does appear in the RSMA primary matching hierarchy, it is ranked well below the (12,12) hierarchal pairing.

Figure 3 depicts results from the RSMA after both primary and secondary matching. Here, all profiles have the same number of data points (levels), 98, and the nth point in any one profile is matched to the nth points of the other profiles. Figure 3 shows the spacing between matched profile levels is quite variable, owing to the spatial distribution of unmatched data points after primary matching. Tabular height and refractivity values corresponding to the matched profile levels of Figure 3 can be found in the Appendix; they are output from the RSMA. These particular height and refractivity arrays (of 98 elements) would not be suitable for direct entry into the RPO program, since that program limits the number of levels to no more than 51. To meet such a limit, it would have been necessary to "thin" (i.e., decrease the number of data points of) the original M-profiles, lessen the number of profiles, or do a combination of both.

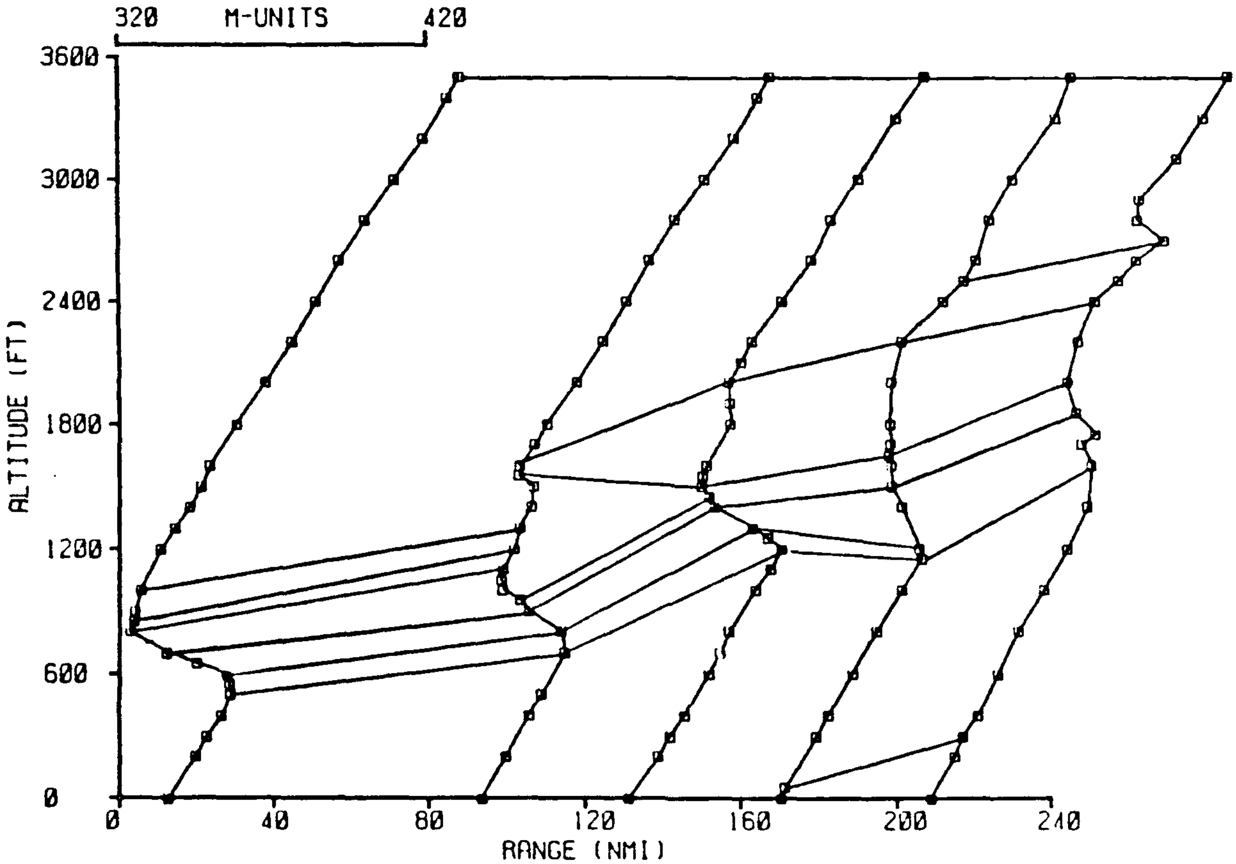

Figure 2. Matched profile structures, indicated by line segments, after RSMA primary matching, for the Pt. Loma to Guadalupe Is. transect of 12 March 1948.

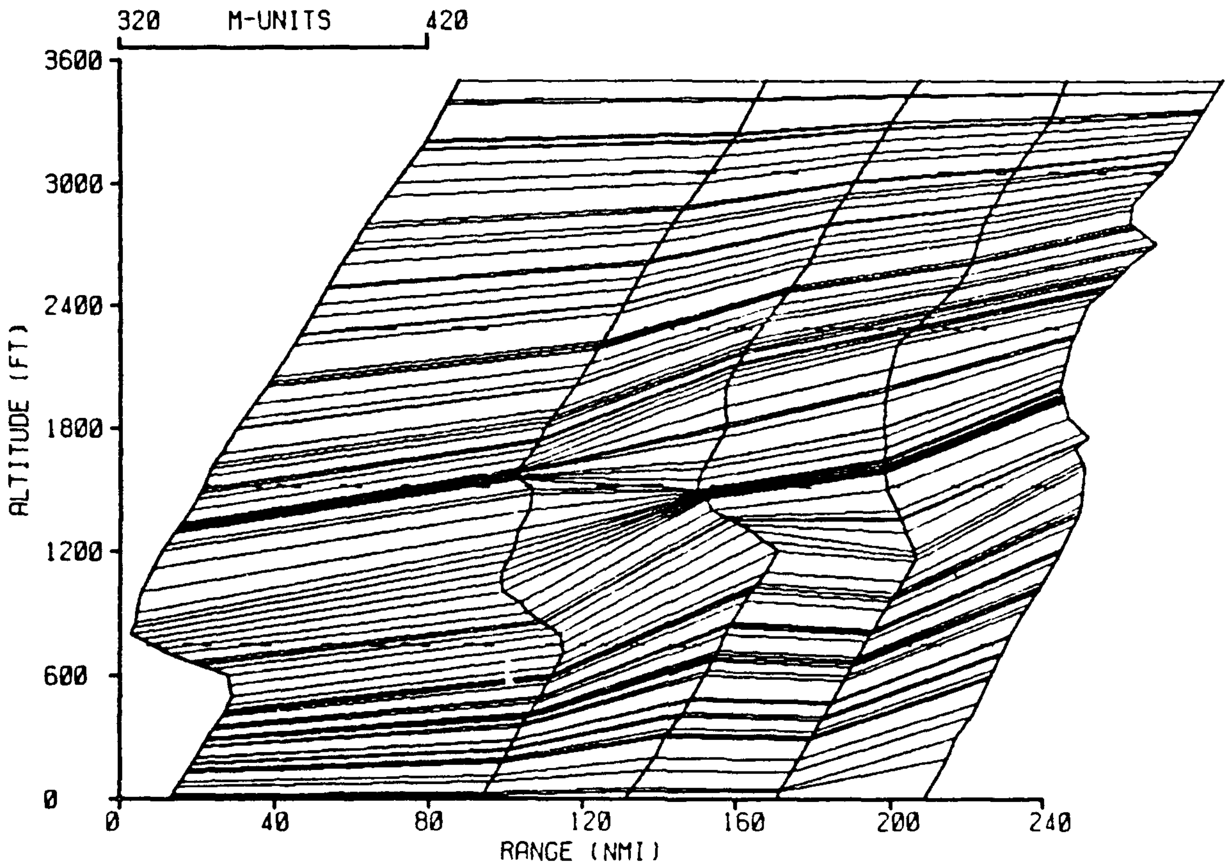

Figure 3. Matched profile structures, indicated by line segments, after RSMA primary and secondary matching, for the Pt. Loma to Guadalupe Is. transect of 12 March 1948.

Interpolation of processed M-profiles to intermediate ranges is not a function of the RSMA, since this task is performed by the RPO program. Nonetheless, during the developmental stage of the RSMA, linear interpolation of M-profiles in range between points in adjacent matched profiles was performed. Figure 4 depicts profiles at intermediate ranges, at increments of 8 nmi. Such a graphical display allows the viewer to clearly see the evolution of refractive layers over range, and points out the heterogeneous, range-dependent nature of large-scale refractivity fields.

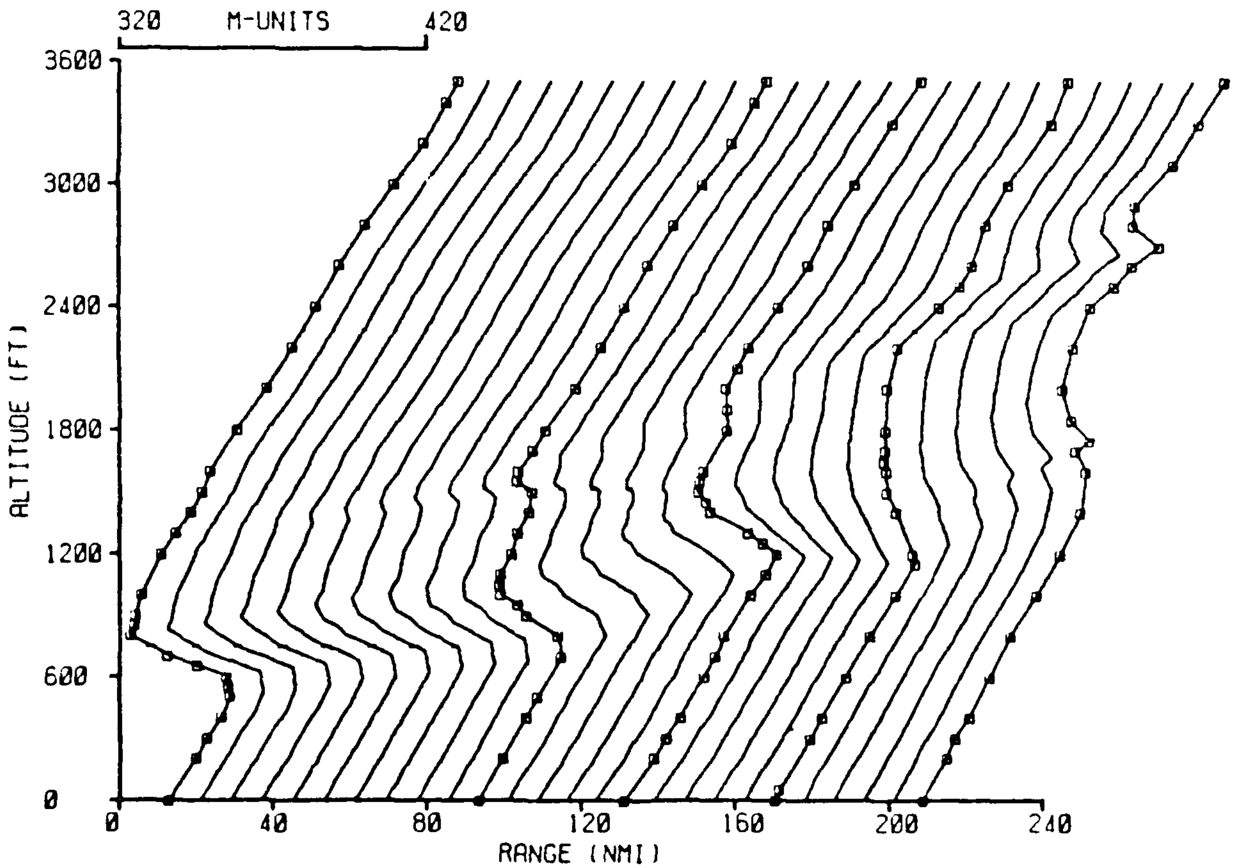

Figure 4. Original and intermediate (derived) M-profiles, for the Pt. Loma to Guadalupe Is. transect of 12 March 1948. Intermediate profiles are interpolated, using the final matched profile structures from the RSMA (Fig. 3).

REFERENCES

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APPENDIX - RSMA COMPUTER LISTING

The RSMA is written in ANSI Fortran 77.

The output from the DEMO Program follows the computer code.

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C                          RSMA
C       REFRACTIVITY STRUCTURE MATCHING ALGORITHM
C
CCCCCCCCCCCCCCCCCCCC  MAIN PROGRAM  CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C  INPUTS VARIABLE    DESCRIPTION                    (VALID RANGE,UNITS)
C         NPRF        NO. OF PROFILES                         2-11
C         NPT(I)      NO. OF POINTS, ITH PROFILE              3-30
C         Z(I,NPT(I)) HEIGHT ARRAY, ITH PROFILE
C         ZUNIT       HEIGHT UNIT                         ' M' OR 'FT'
C         R(I,NPT(I)) REFRACTIVITY ARRAY, ITH PROFILE       M-UNITS
C         RANGE(I)    RANGE, ITH PROFILE                      >= 0.
C         RUNIT       RANGE UNIT                     ' KM',' MI' OR 'NMI'
C
C OUTPUTS VARIABLE    DESCRIPTION                    (VALID RANGE,UNITS)
C         IPMX        NO. OF PROFILE LEVELS
C                     AFTER RIA PROGRAM EXECUTION
C         ZI(I,IPMX)  HEIGHT ARRAY, ITH PROFILE
C         RI(I,IPMX)  INTERPOLATED REFRACTIVITY                M-UNITS
C                     ARRAY, ITH PROFILE
C
C  THE RSMA IS DESIGNED TO PREPARE MULTIPLE M-UNIT PROFILES (GIVEN AS
C  A FUNCTION OF RANGE) FOR ENTRY INTO THE NOSC RADIO PHYSICAL OPTICS
C  (RPO) PROGRAM. THE RPO REQUIRES ALL PROFILES TO HAVE THE SAME NUMBER
C  OF LEVELS, AND LIMITS THE NUMBER OF LEVELS TO NO MORE THAN 51. IN
C  GENERAL, THE NUMBER OF PROFILE LEVELS DETERMINED BY THE RSMA DEPENDS
C  UPON THE NUMBER OF PROFILES, THE NUMBER OF PROFILE POINTS, AND THE
C  NUMBER OF COMMON REFRACTIVITY FEATURES MATCHED BETWEEN PROFILES. A
C  PRIORI, THIS LAST ELEMENT IS NOT KNOWN. OPERATIONALLY, FOR A DECENT
C  LIKELIHOOD IN MEETING THE RPO REQUIREMENT OF NO MORE THAN 51 LEVELS,
C  THE MAXIMUM POSSIBLE NUMBER OF LEVELS AFTER RSMA EXECUTION, NLVMX,
C  GIVEN BY Σ NPT(I) - (NPRF*2) + 2 , SHOULD NOT EXCEED THIS LIMIT
C  BY MORE THAN 50% (NLVMX = ~75) PRIOR TO RSMA EXECUTION.
C  THE FOLLOWING PROGRAM IS A DEMONSTRATION DRIVER FOR THE RSMA SUB-
C  ROUTINE. THE INPUT DATA SET CONSISTS OF HIGH RESOLUTION REFRACTIVITY
C  PROFILES FROM GUADALUPE ISLAND. SINCE THE PROFILES ARE GIVEN IN
C  N-UNITS, THEY WERE CONVERTED TO M-UNITS PRIOR TO CALL TO THE RSMA
C  SUBROUTINE. FOR THIS PARTICULAR DEMONSTRATION DATA SET, THE ACTUAL
C  NUMBER OF PROFILE LEVELS DETERMINED BY THE RSMA (IPMX = 98) SIGNIFI-
```

```
C   CANTLY EXCEEDS THE RPO LIMIT OF 51 LEVELS.
C
C                        START DEMO PROGRAM
C
      PROGRAM RFSTMT
C
      CHARACTER*2 ZUNIT
      CHARACTER*3 RUNIT
C
C     ENTER PROFILE PARAMETERS
C
      PARAMETER(NPRF=5)
      PARAMETER(ZUNIT='FT',RUNIT='NMI')
C
      DIMENSION NPT(11),RANGE(11)
      DIMENSION Z(11,30),R(11,30)
      DIMENSION ZI(11,310),RI(11,310)
C
C     ENTER PROFILE DATA
C
C     INPUT REQUIREMENTS:  1) BOTH RANGE AND HEIGHT ARRAY VALUES
C                             MUST BE IN ASCENDING ORDER.
C                          2) FIRST RANGE ARRAY ELEMENT MUST BE ZERO.
C                          3) ALL HEIGHT PROFILES MUST HAVE THE SAME
C                             VALUES FOR THE FIRST (AND LAST) ARRAY
C                             ELEMENTS.
C
      DATA (NPT(I),I=1,5)/28,28,28,24,24/
      DATA (RANGE(I),I=1,5)/0.,80.,120.,160.,200./
C
      DATA (Z(1,J),J=1,28)/0.,200.,300.,400.,500.,550.,600.,650.,700.,
     *     800.,850.,900.,1000.,1200.,1300.,1400.,1500.,1600.,1800.,
     *     2000.,2200.,2400.,2600.,2800.,3000.,3200.,3400.,3500./
      DATA (R(1,J),J=1,28)/336.,335.,334.,334.,332.,329.,326.,314.,
     *     302.,285.,284.,282.,279.,276.,276.,276.,275.,273.,
     *     272.,272.,271.,269.,267.,266.,266.,266.,264.,263./
      DATA (Z(2,J),J=1,28)/0.,200.,400.,500.,700.,800.,900.,950.,1000.,
     *     1050.,1100.,1200.,1300.,1400.,1500.,1550.,1600.,1700.,1800.,
     *     2000.,2200.,2400.,2600.,2800.,3000.,3200.,3400.,3500./
      DATA (R(2,J),J=1,28)/337.,335.,333.,332.,330.,324.,309.,304.,
     *     296.,293.,291.,290.,287.,286.,282.,275.,273.,273.,
     *     272.,272.,271.,269.,267.,266.,266.,266.,264.,263./
      DATA (Z(3,J),J=1,28)/0.,200.,300.,400.,600.,700.,800.,1000.,
     *     1100.,1200.,1250.,1300.,1400.,1450.,1500.,1550.,1600.,1800.,
     *     1900.,2000.,2100.,2200.,2400.,2600.,2800.,3000.,3300.,3500./
      DATA (R(3,J),J=1,28)/334.,334.,333.,333.,331.,330.,328.,327.,
     *     327.,326.,319.,312.,295.,291.,286.,284.,283.,281.,
     *     276.,271.,270.,269.,269.,269.,266.,265.,263.,263./
      DATA (Z(4,J),J=1,24)/0.,50.,300.,400.,600.,800.,1000.,1150.,
```

```
     *      1200.,1400.,1500.,1600.,1650.,1700.,1800.,2000.,
     *      2200.,2400.,2500.,2600.,2800.,3000.,3300.,3500./
      DATA (R(4,J),J=1,24)/333.,332.,330.,329.,327.,325.,324.,323.,
     *      320.,305.,297.,292.,289.,287.,282.,273.,
     *      267.,271.,273.,272.,267.,265.,265.,261./
      DATA (Z(5,J),J=1,24)/0.,200.,300.,400.,600.,800.,1000.,1200.,
     *      1400.,1600.,1700.,1750.,1850.,2000.,2200.,2400.,
     *      2500.,2600.,2700.,2800.,2900.,3100.,3300.,3500./
      DATA (R(5,J),J=1,24)/331.,329.,327.,327.,324.,321.,320.,318.,
     *      315.,307.,299.,301.,290.,280.,274.,270.,
     *      273.,274.,278.,265.,261.,264.,263.,262./
C
C     OPEN OUTPUT FILE
C
      OPEN(9,FILE='OUTFIL',STATUS='NEW')
C
C     CONVERT N-UNITS TO M-UNITS
C
      DO 10 I = 1,NPRF
C
         JM = NPT(I)
C
         DO 20 J = 1,JM
C
            R(I,J) = R(I,J) + (Z(I,J)*.3048*.157)
C
   20    CONTINUE
C
   10 CONTINUE
C
C     CALL RSMA SUBROUTINE
C
      CALL RSMA(NPRF,ZUNIT,RUNIT,NPT,RANGE,Z,R,ZI,RI,IPMX)
C
C     WRITE OUTPUT FILE
C
      WRITE(9,30) IPMX
   30 FORMAT('NUMBER OF LEVELS=',I4)
C
      DO 40 I = 1,IPMX
C
         WRITE(9,'(10F7.1)') (ZI(M,I),RI(M,I),M=1,NPRF)
   40 CONTINUE
C
      STOP
C
C                        END DEMO PROGRAM
C
      END
```

```
C
CCCCCCCCCCCCCCCC   START SUBROUTINE RSMA   CCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
      SUBROUTINE RSMA(NPRF,ZUNIT,RUNIT,NPT,RANGE,Z,R,ZI,RI,IPMX)
C
      CHARACTER*2 ZUNIT
      CHARACTER*3 RUNIT
C
      DIMENSION NPT(11),RANGE(11)
      DIMENSION Z(11,30),R(11,30)
      DIMENSION ZI(11,310),RI(11,310)
C
      DIMENSION DM(11,30),DDM(11,30)
      DIMENSION IC(11,30),MATCH(11,30)
      DIMENSION ZM1(30),ZM2(30)
      DIMENSION ZVAL(310),ZIF(11,310),ZIB(11,310)
      DIMENSION ICAT1(36),ICAT2(36)
C
      DATA ICAT1/15,14,13,12,11,10,9,8,7,6,5,4,3,2,1,15,15,14,
     *           14,14,13,13,15,15,15,14,13,12,11,12,10,12,11,10,9,8/
      DATA ICAT2/15,14,13,12,11,10,9,8,7,6,5,4,3,2,1,14,13,13,
     *           12,11,10,11,12,10,11,10,12,11,10,9,8,7,6,5,4,1/
C
      DO 10 I = 1,NPRF
C
         JM = NPT(I)
C
C     CALCULATE DM/DZ
C
         DM(I,1) = 0.0
C
         DO 30 J = 2,JM
C
            DM(I,J) = ( R(I,J) - R(I,J-1) ) / ( Z(I,J) - Z(I,J-1) )
C
            IF(ZUNIT.EQ.'FT') DM(I,J) = ( DM(I,J) / .3048 ) * 1000.
            IF(ZUNIT.EQ.' M') DM(I,J) = DM(I,J) * 1000.
C
   30    CONTINUE
C
C     CALCULATE CHANGE IN DM/DZ AT DATA POINTS
C
         DDM(I,1) = 0.0
         DDM(I,JM) = 0.0
C
         DO 40 J = 2,JM-1
C
            DDM(I,J) = ( DM(I,J+1) - DM(I,J) )
C
```

```
   40 CONTINUE
C
C     CATEGORIZE DATA POINTS USING DM/DZ AND D(DM/DZ)
C
      IC(I,1) = 15
      IC(I,JM) = 15
C
      DO 90 J = 2,JM-1
C
         IF(DDM(I,J).GT.-39. .AND. DDM(I,J).LT.39.) GO TO 100
         IF(DDM(I,J).GT.-78. .AND. DDM(I,J).LE.-39.) GO TO 110
         IF(DDM(I,J).GE.78.) GO TO 120
         IF(DDM(I,J).GE.39. .AND. DDM(I,J).LT.78.) GO TO 130
C
C     DDM(I,J) <= -78.
C
         IF(DM(I,J).LT.157.) GO TO 91
         IF(DM(I,J+1).LT.0.) IC(I,J) = -15
         IF(DM(I,J+1).GE.0. .AND. DM(I,J+1).LT.78.) IC(I,J) = -13
         IF(DM(I,J+1).GE.78. .AND. DM(I,J+1).LT.157.) IC(I,J) = -10
         IF(DM(I,J+1).GE.157.) IC(I,J) = -8
C
   91    IF(DM(I,J).LT.78. .OR. DM(I,J).GE.157.) GO TO 92
         IF(DM(I,J+1).LT.0.) IC(I,J) = -14
         IF(DM(I,J+1).GE.0. .AND. DM(I,J+1).LT.78.) IC(I,J) = -11
C
   92    IF(DM(I,J).LT.0. .OR. DM(I,J).GE.78.) GO TO 93
         IF(DM(I,J+1).LT.0.) IC(I,J) = -12
C
   93    IF(DM(I,J).LT.0.) IC(I,J) = -9
         GO TO 90
C
C     DDM(I,J) > -78. .AND. DDM(I,J) <= -39.
C
  110    IF(DM(I,J).LT.157.) GO TO 111
         IF(DM(I,J+1).GE.78. .AND. DM(I,J+1).LT.157.) IC(I,J) = -5
         IF(DM(I,J+1).GE.157.) IC(I,J) = -1
C
  111    IF(DM(I,J).LT.78. .OR. DM(I,J).GE.157.) GO TO 112
         IF(DM(I,J+1).GE.0. .AND. DM(I,J+1).LT.78.) IC(I,J) = -6
         IF(DM(I,J+1).GE.78. .AND. DM(I,J+1).LT.157.) IC(I,J) = -2
C
  112    IF(DM(I,J).LT.0. .OR. DM(I,J).GE.78.) GO TO 113
         IF(DM(I,J+1) .LT.0.) IC(I,J) = -7
         IF(DM(I,J+1).GE.0. .AND. DM(I,J+1).LT.78.) IC(I,J) = -3
C
  113    IF(DM(I,J).LT.0.) IC(I,J) = -4
         GO TO 90
C
```

```
C     DDM(I,J) >= 78.
C
  120    IF(DM(I,J+1).LT.157.) GO TO 121
         IF(DM(I,J).LT.0.) IC(I,J) = 15
         IF(DM(I,J).GE.0. .AND. DM(I,J).LT.78.) IC(I,J) = 13
         IF(DM(I,J).GE.78. .AND. DM(I,J).LT.157.) IC(I,J) = 10
         IF(DM(I,J).GE.157.) IC(I,J) = 8
C
  121    IF(DM(I,J+1).LT.78. .OR. DM(I,J+1).GE.157.) GO TO 122
         IF(DM(I,J).LT.0.) IC(I,J) = 14
         IF(DM(I,J).GE.0. .AND. DM(I,J).LT.78.) IC(I,J) = 11
C
  122    IF(DM(I,J+1).LT.0. .OR. DM(I,J+1).GE.78.) GO TO 123
         IF(DM(I,J).LT.0.) IC(I,J) = 12
C
  123    IF(DM(I,J+1).LT.0.) IC(I,J) = 9
         GO TO 90
C
C     DDM(I,J) >= 39. .AND. DDM(I,J) < 78.
C
  130    IF(DM(I,J+1).LT.157.) GO TO 131
         IF(DM(I,J).GE.78. .AND. DM(I,J).LT.157.) IC(I,J) = 5
         IF(DM(I,J).GE.157.) IC(I,J) = 1
C
  131    IF(DM(I,J+1).LT.78. .OR. DM(I,J+1).GE.157.) GO TO 132
         IF(DM(I,J).GE.0. .AND. DM(I,J).LT.78.) IC(I,J) = 6
         IF(DM(I,J).GE.78. .AND. DM(I,J).LT.157.) IC(I,J) = 2
C
  132    IF(DM(I,J+1).LT.0. .OR. DM(I,J+1).GE.78.) GO TO 133
         IF(DM(I,J).LT.0.) IC(I,J) = 7
         IF(DM(I,J).GE.0. .AND. DM(I,J).LT.78.) IC(I,J) = 3
C
  133    IF(DM(I,J+1).LT.0.) IC(I,J) = 4
         GO TO 90
C
  100    IC(I,J) = 0
C
   90 CONTINUE
C
   10 CONTINUE
C
C     MATCH DATA POINTS OF IDENTICAL, THEN SIMILAR, CATEGORIES,
C     BASED ON MATCH HIERARCHY
C
      FTM = 3.2808399
C
      IF(ZUNIT.EQ.'FT' .AND. RUNIT.EQ.' MI') RFCT = 5.28
      IF(ZUNIT.EQ.'FT' .AND. RUNIT.EQ.'NMI') RFCT = 6.08
      IF(ZUNIT.EQ.'FT' .AND. RUNIT.EQ.' KM') RFCT = 3.28
```

```
      IF(ZUNIT.EQ.' M' .AND. RUNIT.EQ.' MI') RFCT = 1.61
      IF(ZUNIT.EQ.' M' .AND. RUNIT.EQ.'NMI') RFCT = 1.85
      IF(ZUNIT.EQ.' M' .AND. RUNIT.EQ.' KM') RFCT = 1.00
C
      DO 200 M = 1,NPRF-1
C
         RDEP = RFCT * (RANGE(M+1) - RANGE(M))
         NMX1 = NPT(M)
         NMX2 = NPT(M+1)
C
         DO 210 ICAT = 1,36
C
         DO 220 IP = 1,4
C
            IF(IP.EQ.1) J1 = -1 * ICAT1(ICAT)
            IF(IP.EQ.1) J2 = -1 * ICAT2(ICAT)
            IF(IP.EQ.2) J1 = ICAT1(ICAT)
            IF(IP.EQ.2) J2 = ICAT2(ICAT)
            IF(IP.GE.3 .AND. ICAT.LE.15) GO TO 220
            IF(IP.EQ.3) J1 = -1 * ICAT2(ICAT)
            IF(IP.EQ.3) J2 = -1 * ICAT1(ICAT)
            IF(IP.EQ.4) J1 = ICAT2(ICAT)
            IF(IP.EQ.4) J2 = ICAT1(ICAT)
C
            DO 230 N1 = 1,NMX1
C
               IF(IP.EQ.1 .AND. ICAT.EQ.1) MATCH(M,N1) = 0
C
               IF(IC(M,N1).NE.J1) GO TO 230
               IF(MATCH(M,N1).NE.0) GO TO 230
C
               ICNT = 0
C
               IF(ZUNIT.EQ.' M') GO TO 233
C
               IF(Z(M,N1).LT.100.) WNDW = RDEP + 200.
               IF(Z(M,N1).GE.100.) WNDW = RDEP +
     *                                  (100.*(ALOG10(Z(M,N1))))
               GO TO 237
C
  233          IF(Z(M,N1).LT.(100./FTM)) WNDW = RDEP + (200./FTM)
               IF(Z(M,N1).GE.(100./FTM)) WNDW = RDEP +
     *                            ((100./FTM)*(ALOG10((Z(M,N1)*FTM))))
C
  237          ZMIN = Z(M,N1) - WNDW
               ZMIN = MAX(Z(M,1),ZMIN)
               ZMAX = Z(M,N1) + WNDW
               ZMAX = MIN(Z(M,NMX1);ZMAX)
C
```

```
            DO 240 N2 = 1,NMX2
C
               IF(Z(M+1,N2).LT.ZMIN .OR. Z(M+1,N2).GT.ZMAX) GO TO 240
C
               IF(IC(M+1,N2).NE.J2) GO TO 240
C
               ICNT = ICNT + 1
               IF(ICNT.GT.1) GO TO 250
C
               MATCH(M,N1) = N2
               CALL MTHCHK(MATCH,M,NMX1,IFLAG)
C
               IF (IFLAG.EQ.0) GO TO 260
C
C     IFLAG = 1   REJECT MATCH; RESET COUNTER AND MATCH VALUE
C
               ICNT = 0
               MATCH(M,N1) = 0
               GO TO 240
C
 260           MTHINT = N2
               ZDIF = ABS(Z(M,N1) - Z(M+1,N2))
               GO TO 240
C
 250           ZDIFN = ABS(Z(M,N1) - Z(M+1,N2))
               IF(ZDIFN.GE.ZDIF) GO TO 240
C
               MATCH(M,N1) = N2
               CALL MTHCHK(MATCH,M,NMX1,IFLAG)
C
               IF (IFLAG.EQ.0) GO TO 270
C
C    IFLAG = 1   REJECT MATCH; RESET COUNTER AND MATCH VALUE
C
               ICNT = ICNT - 1
               MATCH(M,N1) = MTHINT
               GO TO 240
C
 270           MTHINT = N2
               ZDIF = ZDIFN
C
 240        CONTINUE
C
 230        CONTINUE
C
 220     CONTINUE
 210     CONTINUE
C
 200 CONTINUE
```

```
C
C     PERFORM FORWARD, THEN BACKWARD, MATCHING; ON COMPLETION,
C     ALL PROFILE DATA ARE MATCHED SUCH THAT ALL PROFILES HAVE
C     SAME NUMBER OF POINTS.
C
      DO 400 ID = 1,2
C
         IF(ID.EQ.1) M1 = 1
         IF(ID.EQ.1) M2 = NPRF-1
         IF(ID.EQ.1) M3 = 1
         IF(ID.EQ.2) M1 = NPRF
         IF(ID.EQ.2) M2 = 2
         IF(ID.EQ.2) M3 = -1
C
         DO 405 M = M1,M2,M3
C
            IF(ID.EQ.1) NMX = NPT(M)
            IF(ID.EQ.2) NMX = NPT(M-1)
            NMP = 0
C
            DO 410 N = 1,NMX
               IF(ID.EQ.2) GO TO 415
C
               L = MATCH(M,N)
               IF(MATCH(M,N).EQ.0) GO TO 410
               NMP= NMP + 1
               ZM1(NMP) = Z(M,N)
               ZM2(NMP) = Z(M+1,L)
               GO TO 410
C
  415          L = MATCH(M-1,N)
               IF(MATCH(M-1,N).EQ.0) GO TO 410
               NMP = NMP + 1
               ZM1(NMP) = Z(M,L)
               ZM2(NMP) = Z(M-1,N)
C
  410       CONTINUE
C
            IF(M.EQ.1 .OR. M.EQ. NPRF) NPI = NPT(M)
            IF(M.GT.1 .AND. M.LT.NPRF) NPI = IP
            NMP = 0
            NIP = 0
C
            DO 420 N = 1,NPI-1
               IF(M.EQ.1 .OR. M.EQ.NPRF) ZVAL(N) = Z(M,N)
               IF(N.EQ.1) GO TO 430
               IF(ZVAL(N).EQ.ZT) GO TO 430
C
               NIP = NIP + 1
```

```
              IF(ID.EQ.1)
     *        ZIF(M+1,NIP) = (((ZVAL(N)-ZB)/ZDIF1)*ZDIF2) + ZM2(NMP)
              IF(ID.EQ.2)
     *        ZIB(M-1,NIP) = (((ZVAL(N)-ZB)/ZDIF1)*ZDIF2) + ZM2(NMP)
              GO TO 420
C
  430         NMP = NMP + 1
              ZB = ZM1(NMP)
              ZT = ZM1(NMP+1)
              ZDIF1 = ZM1(NMP+1) - ZM1(NMP)
              ZDIF2 = ZM2(NMP+1) - ZM2(NMP)
C
  420       CONTINUE
C
            IP = 1
            IF(ID.EQ.1) ZVAL(1) = Z(M+1,1)
            IF(ID.EQ.2) ZVAL(1) = Z(M-1,1)
C
            IF(ID.EQ.1) NMX = NPT(M+1)
            IF(ID.EQ.2) NMX = NPT(M-1)
            NINT = 1
C
            DO 440 N = 2,NMX
C
              IFLAG = 0
              NUMINT = 0
              IF(NINT.GT.NIP) GO TO 460
C
              DO 450 L = NINT,NIP
C
                IF(ID.EQ.1 .AND. ZIF(M+1,L).GE.Z(M+1,N)) GO TO 450
                IF(ID.EQ.2 .AND. ZIB(M-1,L).GE.Z(M-1,N)) GO TO 450
C
                IFLAG = 1
                NUMINT = NUMINT + 1
                IP = IP + 1
                IF(ID.EQ.1) ZVAL(IP) = ZIF(M+1,L)
                IF(ID.EQ.2) ZVAL(IP) = ZIB(M-1,L)
C
  450         CONTINUE
C
              IF(IFLAG.EQ.1) NINT = NINT + NUMINT
C
  460         IP = IP + 1
              IF(ID.EQ.1) ZVAL(IP) = Z(M+1,N)
              IF(ID.EQ.2) ZVAL(IP) = Z(M-1,N)
C
  440       CONTINUE
C
```

```
            IF(ID.EQ.2) GO TO 470
C
            IF(M.NE.(NPRF-1)) GO TO 405
            IPMX = IP
C
            DO 480 N = 1,IP
               ZI(M+1,N) = ZVAL(N)
  480       CONTINUE
            GO TO 405
C
  470       IF(M.NE.2) GO TO 490
C
            DO 500 N = 1,IP
               ZI(M-1,N) = ZVAL(N)
  500       CONTINUE
            GO TO 405
C
  490       NZIF = IPMX - IP
C
            I = 1
            ZI(M-1,1) = Z(M-1,1)
            NINT = 1
C
            DO 510 N = 2,IP
C
               IFLAG = 0
               NUMINT = 0
               IF(NINT.GT.NZIF) GO TO 520
C
               DO 530 L = NINT,NZIF
C
                  IF(ZIF(M-1,L).GE.ZVAL(N)) GO TO 530
                  IFLAG = 1
                  NUMINT = NUMINT + 1
                  I = I + 1
                  ZI(M-1,I) = ZIF(M-1,L)
C
  530          CONTINUE
C
               IF(IFLAG.EQ.1) NINT = NINT + NUMINT
C
  520          I = I + 1
               ZI(M-1,I) = ZVAL(N)
C
  510       CONTINUE
C
  405    CONTINUE
  400 CONTINUE
C
```

```
C     REMOVE REPETITIONS IN ZI ARRAYS.
C
      DO 540 M = 1,NPRF
C
         IMX = IPMX - 1
C
         DO 550 I = 1,IMX
C
            IF(I.GT.IMX) GO TO 550
            IF(ZI(M,I+1).NE.ZI(M,I)) GO TO 550
C
            II = I + 1
C
            DO 560 J = II,IMX
C
               ZI(M,J) = ZI(M,J+1)
C
  560       CONTINUE
C
            IMX = IMX - 1
C
  550    CONTINUE
  540 CONTINUE
C
      IPMX = IMX + 1
C
C
C     CALCULATE RI VALUES FOR ZI POINTS, USING LINEAR INTERPOLATION.
C
      DO 600 M = 1,NPRF
         NMX = NPT(M)
         INIT = 1
C
         DO 610 N = 1,NMX-1
            NUMINT = 0
C
            RB = R(M,N)
            RT = R(M,N+1)
            RDIF = RT - RB
            ZB = Z(M,N)
            ZT = Z(M,N+1)
            ZDIF = ZT - ZB
C
            DO 620 I = INIT,IPMX
C
               IF(ZI(M,I).EQ.ZT) GO TO 630
C
               RI(M,I) = RB + (((ZI(M,I)-ZB)/ZDIF)*RDIF)
               NUMINT = NUMINT + 1
C
```

```
  620        CONTINUE
C
  630        INIT = INIT + NUMINT
             IF(I.EQ.IPMX) RI(M,I) = RT
C
  610     CONTINUE
  600  CONTINUE
C
       RETURN
       END
C
       SUBROUTINE MTHCHK(MATCH,M,N,IFLAG)
C
       DIMENSION MATCH(11,30)
C
       IFLAG = 0
C
       LOW = MATCH(M,1)
C
       DO 100 I = 2,N
C
          IF(MATCH(M,I).EQ.0) GO TO 100
C
          NEXT = MATCH(M,I)
          IF(NEXT.LE.LOW) GO TO 200
          LOW = NEXT
          GO TO 100
C
  200     IFLAG = 1
C
  100     CONTINUE
C
          RETURN
          END
```

OUTPUT - DEMO PROGRAM

NUMBER OF LEVELS= 98

.0	336.0	.0	337.0	.0	334.0	.0	333.0	.0	331.0
14.5	336.6	20.3	337.8	34.8	335.7	33.3	333.9	200.0	338.6
21.7	336.9	30.4	338.2	52.2	336.5	50.0	334.4	300.0	341.4
58.5	338.5	81.9	340.1	140.5	340.7	134.6	337.8	400.0	346.1
83.3	339.6	116.7	341.4	200.0	343.6	191.7	340.0	467.4	348.4
125.0	341.4	175.0	343.6	300.0	347.4	287.5	343.9	580.7	352.1
130.4	341.6	182.6	343.9	313.0	348.0	300.0	344.4	595.5	352.6
132.1	341.7	184.9	344.0	317.1	348.2	303.8	344.5	600.0	352.7
142.9	342.1	200.0	344.6	342.9	349.4	328.6	345.4	629.2	353.7
166.7	343.1	233.3	345.8	400.0	352.1	383.3	347.5	693.9	355.8
173.9	343.5	243.5	346.2	417.4	352.8	400.0	348.1	713.6	356.4
200.0	344.6	280.0	347.6	480.0	355.2	460.0	350.4	784.5	358.8
205.7	344.8	288.0	347.9	493.6	355.7	473.1	350.9	800.0	359.3
250.0	346.5	350.0	350.2	600.0	359.7	575.0	354.8	920.5	364.4
260.9	346.9	365.2	350.8	626.1	360.7	600.0	355.7	950.0	365.7
279.3	347.6	391.0	351.8	670.2	362.4	642.3	357.3	1000.0	367.9
285.7	347.8	400.0	352.1	685.7	363.0	657.1	357.9	1017.5	368.5
291.7	348.0	408.3	352.5	700.0	363.5	670.8	358.4	1033.7	369.1
300.0	348.4	420.0	352.9	720.0	364.1	690.0	359.1	1056.4	370.0
333.3	350.0	466.7	354.7	800.0	366.3	766.7	362.0	1147.0	373.4
347.8	350.6	487.0	355.4	834.8	367.8	800.0	363.3	1186.4	374.9
352.8	350.9	494.0	355.7	846.8	368.3	811.5	363.8	1200.0	375.4
357.1	351.1	500.0	355.9	857.1	368.7	821.4	364.2	1211.7	375.8
400.0	353.1	560.0	358.2	960.0	373.1	920.0	368.4	1328.2	379.6
416.7	353.6	583.3	359.1	1000.0	374.9	958.3	370.1	1373.5	381.1
426.4	353.9	597.0	359.6	1023.4	376.0	980.8	371.0	1400.0	382.0
434.8	354.1	608.7	360.0	1043.5	376.9	1000.0	371.9	1422.7	382.2
458.3	354.8	641.7	361.3	1100.0	379.6	1054.2	374.1	1486.7	382.7
500.0	355.9	700.0	363.5	1200.0	383.4	1150.0	378.0	1600.0	383.6
550.0	355.3	750.0	362.9	1250.0	378.8	1175.0	377.7	1617.9	383.0
600.0	354.7	800.0	362.3	1300.0	374.2	1200.0	377.4	1635.7	382.4
630.0	348.9	830.0	359.2	1330.0	370.5	1290.0	375.0	1700.0	380.4
650.0	345.1	850.0	357.2	1350.0	368.1	1350.0	373.4	1742.9	384.1
653.3	344.5	853.3	356.8	1353.3	367.7	1360.0	373.1	1750.0	384.7
666.7	341.9	866.7	355.5	1366.7	366.1	1400.0	372.0	1778.6	383.0
700.0	335.5	900.0	352.1	1400.0	362.0	1500.0	368.8	1850.0	378.5
725.0	332.4	950.0	349.5	1450.0	360.4	1575.0	368.6	1925.0	377.1
750.0	329.4	1000.0	343.9	1454.2	360.2	1581.3	368.6	1931.3	377.0
775.0	326.3	1050.0	343.2	1458.3	360.0	1587.5	368.6	1937.5	376.9
800.0	323.3	1100.0	343.6	1462.5	359.7	1593.8	368.6	1943.8	376.8
825.0	324.0	1150.0	345.5	1466.7	359.5	1600.0	368.6	1950.0	376.6
850.0	324.7	1200.0	347.4	1470.8	359.3	1606.3	368.5	1956.3	376.5
900.0	325.1	1233.3	348.0	1473.6	359.2	1610.4	368.4	1960.4	376.5

1000.0	326.9	1300.0	349.2	1479.2	358.9	1618.8	368.3	1968.8	376.3
1113.6	330.6	1400.0	353.0	1487.5	358.4	1631.3	368.2	1981.3	376.1
1200.0	333.4	1476.0	353.6	1493.8	358.1	1640.8	368.1	1990.8	375.9
1227.3	334.7	1500.0	353.8	1495.8	358.0	1643.8	368.0	1993.8	375.8
1284.1	337.4	1550.0	349.2	1500.0	357.8	1650.0	368.0	2000.0	375.7
1289.3	337.7	1554.5	349.2	1545.5	358.1	1700.0	368.4	2036.4	376.4
1289.8	337.7	1555.0	349.2	1550.0	358.2	1705.0	368.3	2040.0	376.4
1295.5	338.0	1560.0	349.3	1600.0	359.6	1760.0	368.2	2080.0	377.1
1299.6	338.2	1563.6	349.3	1636.4	360.9	1800.0	368.1	2109.1	377.7
1300.0	338.2	1564.0	349.3	1640.0	361.1	1804.0	368.1	2112.0	377.7
1312.5	338.8	1575.0	349.4	1750.0	365.2	1925.0	368.5	2200.0	379.3
1318.2	339.1	1580.0	349.4	1800.0	367.1	1980.0	368.7	2240.0	380.4
1320.2	339.2	1581.8	349.4	1818.2	367.1	2000.0	368.7	2254.5	380.8
1329.5	339.6	1590.0	349.5	1900.0	366.9	2090.0	370.3	2320.0	382.6
1340.9	340.2	1600.0	349.6	2000.0	366.7	2200.0	372.3	2400.0	384.8
1400.0	343.0	1652.0	352.1	2041.1	368.3	2235.6	374.7	2435.6	387.6
1454.5	345.1	1700.0	354.4	2078.9	369.7	2268.4	376.9	2468.4	390.2
1484.8	346.2	1726.7	355.4	2100.0	370.5	2286.7	378.2	2486.7	391.6
1500.0	346.8	1740.0	355.9	2110.5	370.9	2295.8	378.8	2495.8	392.3
1507.0	347.0	1746.2	356.1	2115.4	371.1	2300.0	379.1	2500.0	392.6
1568.2	348.7	1800.0	358.1	2157.9	372.7	2336.8	381.6	2536.8	394.8
1600.0	349.6	1828.0	359.5	2180.0	373.5	2356.0	382.9	2556.0	395.9
1628.8	350.8	1853.3	360.7	2200.0	374.3	2373.3	384.0	2573.3	396.9
1673.1	352.7	1892.3	362.6	2230.8	375.8	2400.0	385.8	2600.0	398.4
1795.5	357.9	2000.0	367.7	2315.8	379.8	2473.7	390.8	2673.7	404.9
1800.0	358.1	2004.0	367.9	2318.9	380.0	2476.4	391.0	2676.4	405.1
1839.2	360.0	2038.5	369.4	2346.2	381.3	2500.0	392.6	2700.0	407.2
1916.7	363.7	2106.7	372.3	2400.0	383.8	2546.7	394.4	2737.3	404.1
2000.0	367.7	2180.0	375.4	2457.9	386.6	2596.8	396.3	2777.5	400.8
2005.2	367.9	2184.6	375.6	2461.5	386.8	2600.0	396.4	2780.0	400.6
2022.7	368.7	2200.0	376.3	2473.7	387.4	2610.5	396.7	2788.4	399.9
2046.8	369.7	2221.2	377.1	2490.4	388.2	2625.0	397.0	2800.0	399.0
2200.0	376.3	2356.0	382.2	2596.8	393.3	2717.3	399.1	2873.8	399.6
2204.5	376.4	2360.0	332.3	2600.0	393.4	2720.0	399.2	2876.0	399.6
2250.0	378.2	2400.0	383.8	2631.6	394.5	2747.4	399.8	2897.9	399.8
2254.4	378.3	2403.8	384.0	2634.6	394.6	2750.0	399.8	2900.0	399.8
2337.4	381.5	2476.9	386.8	2692.3	396.5	2800.0	401.0	2940.0	402.3
2400.0	383.8	2532.0	388.8	2735.8	397.9	2837.7	402.4	2970.1	404.2
2477.3	386.8	2600.0	391.4	2789.5	399.6	2884.2	404.2	3007.4	406.5
2492.4	387.3	2613.3	392.0	2800.0	400.0	2893.3	404.5	3014.7	407.0
2600.0	391.4	2708.0	396.0	2874.7	403.2	2958.1	407.0	3066.5	410.2
2669.6	394.4	2769.2	398.7	2923.1	405.3	3000.0	408.6	3100.0	412.3
2704.5	395.9	2800.0	400.0	2947.4	406.3	3021.1	409.6	3116.8	413.1
2780.3	399.1	2866.7	403.2	3000.0	408.6	3066.7	411.8	3153.3	414.6
2800.0	400.0	2884.0	404.0	3013.7	409.1	3078.5	412.3	3162.8	415.0
2931.8	406.3	3000.0	409.6	3105.3	412.9	3157.9	416.1	3226.3	417.8
3000.0	409.6	3060.0	412.4	3152.6	414.8	3198.9	418.1	3259.2	419.2
3084.8	413.6	3134.6	416.0	3211.5	417.3	3250.0	420.5	3300.0	420.9
3159.1	417.2	3200.0	419.1	3263.2	419.4	3294.7	422.7	3335.8	422.5
3167.8	417.6	3207.7	419.4	3269.2	419.6	3300.0	422.9	3340.0	422.6
3200.0	419.1	3236.0	420.5	3291.6	420.6	3319.4	423.5	3355.5	423.3
3212.1	419.6	3246.7	420.9	3300.0	420.9	3326.7	423.7	3361.3	423.5
3386.4	426.2	3400.0	426.7	3421.1	426.7	3431.6	426.6	3445.3	427.1
3400.0	426.7	3412.0	427.2	3430.5	427.2	3439.8	426.8	3451.8	427.4
3500.0	430.5	3500.0	430.5	3500.0	430.5	3500.0	428.5	3500.0	429.5

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The Refractivity Structure Matching Algorithm (RSMA) is an automated aid for matching refractivity structure in adjacent profiles which result from common layers. The RMSA is specifically designed to prepare multiple refractivity profiles for entry into the Naval Ocean Systems Center's Radio Physical Optics (RPO) program. A full description of the RMSA, a test case demonstrating its capabilities, and a computer listing, are provided in this document.

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